

Σ BARYONS

(S = -1, I = 1)

$$\Sigma^+ = uus, \quad \Sigma^0 = uds, \quad \Sigma^- = dds$$

NODE=BXXX025

Σ⁺

$$I(J^P) = 1(\frac{1}{2}^+)$$

Mass $m = 1189.37 \pm 0.07$ MeV (S = 2.2)Mean life $\tau = (0.8018 \pm 0.0026) \times 10^{-10}$ s $c\tau = 2.404$ cm $(\tau_{\Sigma^+} - \tau_{\Sigma^-}) / \tau_{\Sigma^+} = (-0.6 \pm 1.2) \times 10^{-3}$ Magnetic moment $\mu = 2.458 \pm 0.010 \mu_N$ (S = 2.1) $(\mu_{\Sigma^+} + \mu_{\Sigma^-}) / \mu_{\Sigma^+} = 0.014 \pm 0.015$ $\Gamma(\Sigma^+ \rightarrow n\ell^+\nu) / \Gamma(\Sigma^- \rightarrow n\ell^-\bar{\nu}) < 0.043$ **Decay parameters**

$$p\pi^0 \quad \alpha_0 = -0.980^{+0.017}_{-0.015}$$

$$" \quad \phi_0 = (36 \pm 34)^\circ$$

$$" \quad \gamma_0 = 0.16 [a]$$

$$" \quad \Delta_0 = (187 \pm 6)^\circ [a]$$

$$n\pi^+ \quad \alpha_+ = 0.068 \pm 0.013$$

$$" \quad \phi_+ = (167 \pm 20)^\circ \quad (S = 1.1)$$

$$" \quad \gamma_+ = -0.97 [a]$$

$$" \quad \Delta_+ = (-73^{+133}_{-10})^\circ [a]$$

$$p\gamma \quad \alpha_\gamma = -0.76 \pm 0.08$$

NODE=S019

NODE=S019M;DTYPE=M

NODE=S019T;DTYPE=T

NODE=S019CTA;DTYPE=C;OUR EVAL

NODE=S019DT;DTYPE=x

NODE=S019MM;DTYPE=m

NODE=S019MMD;DTYPE=i

NODE=S019R7;DTYPE=Y;OUR LIM;

→ UNCHECKED ←

CLUMP=D

NODE=S019A0;DTYPE=d;CLUMP=D

NODE=S019F0;DTYPE=d;CLUMP=D

NODE=S019G0;DTYPE=d;CLUMP=D;OUR

EVAL;→ UNCHECKED ←

NODE=S019D0;DTYPE=d;CLUMP=D;OUR

EVAL;→ UNCHECKED ←

NODE=S019A+;DTYPE=d;CLUMP=D

NODE=S019F+;DTYPE=d;CLUMP=D

NODE=S019G+;DTYPE=d;CLUMP=D;OUR

EVAL;→ UNCHECKED ←

NODE=S019D+;DTYPE=d;CLUMP=D;OUR

EVAL;→ UNCHECKED ←

NODE=S019AG;DTYPE=d;CLUMP=D

Σ ⁺ DECAY MODES	Fraction (Γ _i /Γ)	Confidence level	^p (MeV/c)
$p\pi^0$	(51.57±0.30) %		189
$n\pi^+$	(48.31±0.30) %		185
$p\gamma$	(1.23±0.05) × 10 ⁻³		225
$n\pi^+\gamma$	[b] (4.5 ±0.5) × 10 ⁻⁴		185
$\Lambda e^+\nu_e$	(2.0 ±0.5) × 10 ⁻⁵		71

**ΔS = ΔQ (SQ) violating modes or
ΔS = 1 weak neutral current (S1) modes**

$ne^+\nu_e$	SQ	< 5	× 10 ⁻⁶	90%	224
$n\mu^+\nu_\mu$	SQ	< 3.0	× 10 ⁻⁵	90%	202
pe^+e^-	S1	< 7	× 10 ⁻⁶		225
$p\mu^+\mu^-$	S1	(9 ⁺⁹ / ₋₈)	× 10 ⁻⁸		121

NODE=S019220;DESIG=1

DESIG=2

DESIG=5

DESIG=3

DESIG=4

NODE=S019;CLUMP=A

DESIG=7;OUR LIM;→ UNCHECKED ←

DESIG=6;OUR LIM;→ UNCHECKED ←

DESIG=8

DESIG=9

Σ⁰

$$I(J^P) = 1(\frac{1}{2}^+)$$

Mass $m = 1192.642 \pm 0.024$ MeV $m_{\Sigma^-} - m_{\Sigma^0} = 4.807 \pm 0.035$ MeV (S = 1.1) $m_{\Sigma^0} - m_\Lambda = 76.959 \pm 0.023$ MeVMean life $\tau = (7.4 \pm 0.7) \times 10^{-20}$ s $c\tau = 2.22 \times 10^{-11}$ mTransition magnetic moment $|\mu_{\Sigma\Lambda}| = 1.61 \pm 0.08 \mu_N$

NODE=S021

NODE=S021M;DTYPE=M

NODE=S021D1;DTYPE=D

NODE=S021DL;DTYPE=D

NODE=S021T;DTYPE=T;OUR EVAL;

→ UNCHECKED ←

NODE=S02ICTA;DTYPE=C;OUR EVAL

NODE=S021MM;DTYPE=m

Σ^0 DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\gamma$	100 %		74
$\Lambda\gamma\gamma$	< 3 %	90%	74
$\Lambda e^+ e^-$	[c] 5×10^{-3}		74

NODE=S021225;DESIG=1;OUR EVAL;
DESIG=3 UNCHECKED ←
DESIG=2;OUR EVAL;→ UNCHECKED ←

Σ^-

$$I(J^P) = 1(\frac{1}{2}^+)$$

Mass $m = 1197.449 \pm 0.030$ MeV (S = 1.2)
 $m_{\Sigma^-} - m_{\Sigma^+} = 8.08 \pm 0.08$ MeV (S = 1.9)
 $m_{\Sigma^-} - m_{\Lambda} = 81.766 \pm 0.030$ MeV (S = 1.2)
Mean life $\tau = (1.479 \pm 0.011) \times 10^{-10}$ s (S = 1.3)
 $c\tau = 4.434$ cm
Magnetic moment $\mu = -1.160 \pm 0.025 \mu_N$ (S = 1.7)
 Σ^- charge radius = 0.78 ± 0.10 fm

Decay parameters

$n\pi^-$ $\alpha_- = -0.068 \pm 0.008$
" $\phi_- = (10 \pm 15)^\circ$
" $\gamma_- = 0.98$ [a]
" $\Delta_- = (249^{+12}_{-120})^\circ$ [a]
 $ne^- \bar{\nu}_e$ $g_A/g_V = 0.340 \pm 0.017$ [d]
" $f_2(0)/f_1(0) = 0.97 \pm 0.14$
" $D = 0.11 \pm 0.10$
 $\Lambda e^- \bar{\nu}_e$ $g_V/g_A = 0.01 \pm 0.10$ [d] (S = 1.5)
" $g_{WM}/g_A = 2.4 \pm 1.7$ [d]

NODE=S020
NODE=S020M;DTYPE=M
NODE=S020D;DTYPE=D
NODE=S020DL;DTYPE=D
NODE=S020T;DTYPE=T
NODE=S020CTA;DTYPE=C;OUR EVAL
NODE=S020MM;DTYPE=m
NODE=S020CR;DTYPE=x

CLUMP=D

NODE=S020A-;DTYPE=d;CLUMP=D
NODE=S020F-;DTYPE=d;CLUMP=D
NODE=S020G-;DTYPE=d;CLUMP=D;OUR
EVAL;→ UNCHECKED ←
NODE=S020D-;DTYPE=d;CLUMP=D;OUR
EVAL;→ UNCHECKED ←
NODE=S020AV2;DTYPE=d;CLUMP=D
NODE=S020F2;DTYPE=d;CLUMP=D
NODE=S020TC;DTYPE=d;CLUMP=D
NODE=S020AV;DTYPE=d;CLUMP=D
NODE=S020WM;DTYPE=d;CLUMP=D

Σ^- DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$n\pi^-$	(99.848±0.005) %	193
$n\pi^- \gamma$	[b] (4.6 ±0.6) × 10 ⁻⁴	193
$ne^- \bar{\nu}_e$	(1.017±0.034) × 10 ⁻³	230
$n\mu^- \bar{\nu}_\mu$	(4.5 ±0.4) × 10 ⁻⁴	210
$\Lambda e^- \bar{\nu}_e$	(5.73 ±0.27) × 10 ⁻⁵	79

NODE=S020230;DESIG=1
DESIG=2
DESIG=4
DESIG=3
DESIG=5

$\Sigma(1385) 3/2^+$

$$I(J^P) = 1(\frac{3}{2}^+)$$

$\Sigma(1385)^+$ mass $m = 1382.80 \pm 0.35$ MeV (S = 1.9)
 $\Sigma(1385)^0$ mass $m = 1383.7 \pm 1.0$ MeV (S = 1.4)
 $\Sigma(1385)^-$ mass $m = 1387.2 \pm 0.5$ MeV (S = 2.2)
 $\Sigma(1385)^+$ full width $\Gamma = 36.0 \pm 0.7$ MeV
 $\Sigma(1385)^0$ full width $\Gamma = 36 \pm 5$ MeV
 $\Sigma(1385)^-$ full width $\Gamma = 39.4 \pm 2.1$ MeV (S = 1.7)
Below $\bar{K}N$ threshold

NODE=B043

NODE=B043M+;DTYPE=M
NODE=B043M0;DTYPE=M
NODE=B043M-;DTYPE=M
NODE=B043W+;DTYPE=G
NODE=B043W0;DTYPE=G
NODE=B043W-;DTYPE=G

$\Sigma(1385)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\pi$	(87.0 ±1.5) %		208
$\Sigma\pi$	(11.7 ±1.5) %		129
$\Lambda\gamma$	(1.25 ^{+0.13} _{-0.12}) %		241
$\Sigma^+ \gamma$	(7.0 ±1.7) × 10 ⁻³		180
$\Sigma^- \gamma$	< 2.4 × 10 ⁻⁴	90%	173

NODE=B043235;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=3
DESIG=6
DESIG=5

$\Sigma(1660) 1/2^+$

$$I(J^P) = 1(\frac{1}{2}^+)$$

Mass $m = 1630$ to 1690 (≈ 1660) MeV
Full width $\Gamma = 40$ to 200 (≈ 100) MeV
 $p_{\text{beam}} = 0.72$ GeV/c $4\pi\lambda^2 = 29.9$ mb

NODE=B079

NODE=B079M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B079W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B079BB;DTYPE=P;OUR EVAL

$\Sigma(1660)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	10–30 %	405
$\Lambda\pi$	seen	440
$\Sigma\pi$	seen	387

NODE=B079215;DESIG=1;OUR EST
DESIG=3;OUR EST
DESIG=2;OUR EST

$\Sigma(1670) 3/2^-$

$$I(J^P) = 1(\frac{3}{2}^-)$$

Mass $m = 1665$ to 1685 (≈ 1670) MeV
Full width $\Gamma = 40$ to 80 (≈ 60) MeV
 $p_{\text{beam}} = 0.74$ GeV/c $4\pi\lambda^2 = 28.5$ mb

NODE=B044

NODE=B044M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B044W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B044BB;DTYPE=P;OUR EVAL

$\Sigma(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	7–13 %	414
$\Lambda\pi$	5–15 %	448
$\Sigma\pi$	30–60 %	394

NODE=B044215;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=3;OUR EST

$\Sigma(1750) 1/2^-$

$$I(J^P) = 1(\frac{1}{2}^-)$$

Mass $m = 1730$ to 1800 (≈ 1750) MeV
Full width $\Gamma = 60$ to 160 (≈ 90) MeV
 $p_{\text{beam}} = 0.91$ GeV/c $4\pi\lambda^2 = 20.7$ mb

NODE=B057

NODE=B057M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B057W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B057BB;DTYPE=P;OUR EVAL

$\Sigma(1750)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	10–40 %	486
$\Lambda\pi$	seen	507
$\Sigma\pi$	<8 %	456
$\Sigma\eta$	15–55 %	98

NODE=B057215;DESIG=1;OUR EST
DESIG=3;OUR EST
DESIG=4;OUR EST
DESIG=2;OUR EST

$\Sigma(1775) 5/2^-$

$$I(J^P) = 1(\frac{5}{2}^-)$$

Mass $m = 1770$ to 1780 (≈ 1775) MeV
Full width $\Gamma = 105$ to 135 (≈ 120) MeV
 $p_{\text{beam}} = 0.96$ GeV/c $4\pi\lambda^2 = 19.0$ mb

NODE=B045

NODE=B045M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B045W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B045BB;DTYPE=P;OUR EVAL

$\Sigma(1775)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	37–43%	508
$\Lambda\pi$	14–20%	525
$\Sigma\pi$	2–5%	475
$\Sigma(1385)\pi$	8–12%	327
$\Lambda(1520)\pi$	17–23%	201

NODE=B045215;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=5;OUR EST
DESIG=4;OUR EST
DESIG=3;OUR EST

$\Sigma(1915) 5/2^+$

$$I(J^P) = 1(\frac{5}{2}^+)$$

Mass $m = 1900$ to 1935 (≈ 1915) MeV
Full width $\Gamma = 80$ to 160 (≈ 120) MeV
 $p_{\text{beam}} = 1.26$ GeV/c $4\pi\lambda^2 = 12.8$ mb

NODE=B046

NODE=B046M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B046W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B046BB;DTYPE=P;OUR EVAL

$\Sigma(1915)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	5–15 %	618
$\Lambda\pi$	seen	623
$\Sigma\pi$	seen	577
$\Sigma(1385)\pi$	<5 %	443

NODE=B046215;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=3;OUR EST
DESIG=181;OUR EST

$\Sigma(1940) 3/2^-$

$$I(J^P) = 1(\frac{3}{2}^-)$$

Mass $m = 1900$ to 1950 (≈ 1940) MeV

Full width $\Gamma = 150$ to 300 (≈ 220) MeV

$$p_{\text{beam}} = 1.32 \text{ GeV}/c \quad 4\pi\lambda^2 = 12.1 \text{ mb}$$

NODE=B098

NODE=B098M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B098W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B098B;DTYPE=P;OUR EVAL

$\Sigma(1940)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	<20 %	637
$\Lambda\pi$	seen	640
$\Sigma\pi$	seen	595
$\Sigma(1385)\pi$	seen	463
$\Lambda(1520)\pi$	seen	355
$\Delta(1232)\bar{K}$	seen	410
$N\bar{K}^*(892)$	seen	322

NODE=B098215;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=3;OUR EST
DESIG=8;OUR EST
DESIG=181;OUR EST
DESIG=182;OUR EST
DESIG=9;OUR EST

$\Sigma(2030) 7/2^+$

$$I(J^P) = 1(\frac{7}{2}^+)$$

Mass $m = 2025$ to 2040 (≈ 2030) MeV

Full width $\Gamma = 150$ to 200 (≈ 180) MeV

$$p_{\text{beam}} = 1.52 \text{ GeV}/c \quad 4\pi\lambda^2 = 9.93 \text{ mb}$$

NODE=B047

NODE=B047M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B047W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B047B;DTYPE=P;OUR EVAL

$\Sigma(2030)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	17–23 %	702
$\Lambda\pi$	17–23 %	700
$\Sigma\pi$	5–10 %	657
ΞK	<2 %	422
$\Sigma(1385)\pi$	5–15 %	532
$\Lambda(1520)\pi$	10–20 %	430
$\Delta(1232)\bar{K}$	10–20 %	498
$N\bar{K}^*(892)$	<5 %	439

NODE=B047215;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=3;OUR EST
DESIG=4;OUR EST
DESIG=10;OUR EST
DESIG=181;OUR EST
DESIG=182;OUR EST
DESIG=183;OUR EST

$\Sigma(2250)$

$$I(J^P) = 1(?^?)$$

Mass $m = 2210$ to 2280 (≈ 2250) MeV

Full width $\Gamma = 60$ to 150 (≈ 100) MeV

$$p_{\text{beam}} = 2.04 \text{ GeV}/c \quad 4\pi\lambda^2 = 6.76 \text{ mb}$$

NODE=B048

NODE=B048M;DTYPE=M;OUR EST;
→ UNCHECKED ←
NODE=B048W;DTYPE=G;OUR EST;
→ UNCHECKED ←
NODE=B048B;DTYPE=P;OUR EVAL

$\Sigma(2250)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	<10 %	851
$\Lambda\pi$	seen	842
$\Sigma\pi$	seen	803

NODE=B048215;DESIG=1;OUR EST
DESIG=2;OUR EST
DESIG=3;OUR EST

NOTES

[a] The decay parameters γ and Δ are calculated from α and ϕ using

$$\gamma = \sqrt{1-\alpha^2} \cos\phi, \quad \tan\Delta = -\frac{1}{\alpha} \sqrt{1-\alpha^2} \sin\phi.$$

See the "Note on Baryon Decay Parameters" in the neutron Particle Listings.

LINKAGE=SBE

[b] See the Listings for the pion momentum range used in this measurement.

LINKAGE=SD

[c] A theoretical value using QED.

LINKAGE=SU

[d] The parameters g_A , g_V , and g_{WM} for semileptonic modes are defined by $\bar{B}_f[\gamma\lambda(g_V + g_A\gamma_5) + i(g_{WM}/m_{B_i})\sigma_{\lambda\nu}q^\nu]B_i$, and ϕ_{AV} is defined by $g_A/g_V = |g_A/g_V|e^{i\phi_{AV}}$. See the "Note on Baryon Decay Parameters" in the neutron Particle Listings.

LINKAGE=SBD